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(54) **Method of producing medium-grade coated paper for rotogravure printing**

(57) A method of producing medium-grade coated paper for rotogravure printing, comprises applying to either or both surfaces of a base paper containing 10 to 100% by weight of one or more high yield pulps having a 42-mesh on fiber fraction content of below 30%, and 0 to 90% by weight of one or more chemical pulps, a coating composition comprising natural ground calcium carbonate either with a specific surface area in the range of 1.5 to 2.5 m^2/g in an amount of 5 to (95S-137.5)% by weight (where "S" represents the specific surface area in m^2/g of the natural ground calcium carbonate used) of the total pigments present, or with a specific surface area in the range of 2.5 to 5 m^2/g in an amount of 5 to 100% by weight of the total pigments present, the main adhesive of the coating composition being at least one alkali-sensitive synthetic resin emulsion, or a mixture thereof and one or more viscosity-increasing agents.

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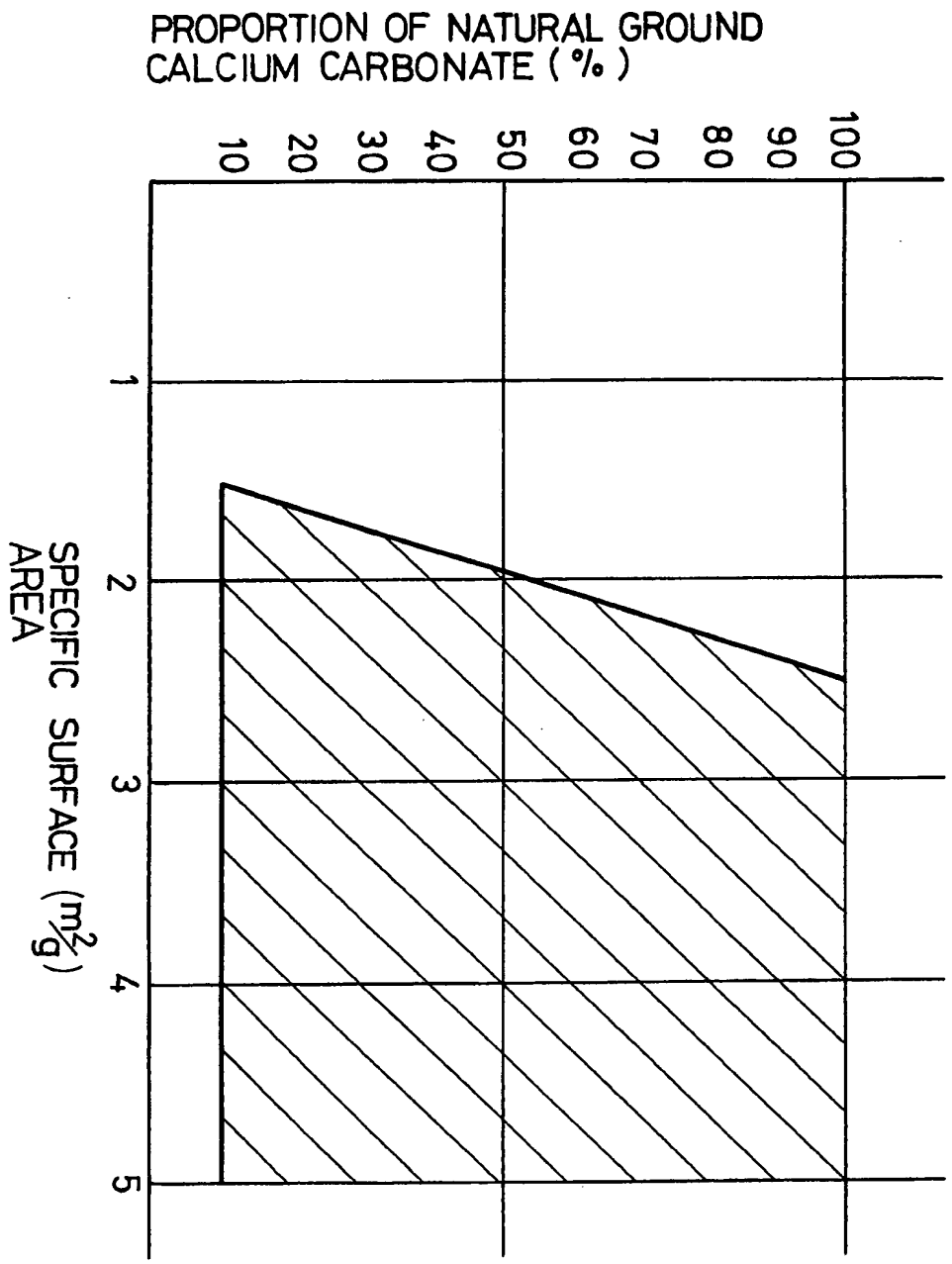

PROPORTION OF NATURAL GROUND CALCIUM CARBONATE (%)
10
20
30
40
50
60
70
80
90
100
SPECIFIC SURFACE AREA (m^2/g)
1
2
3
4
5

FIG. 1

FIG. 2

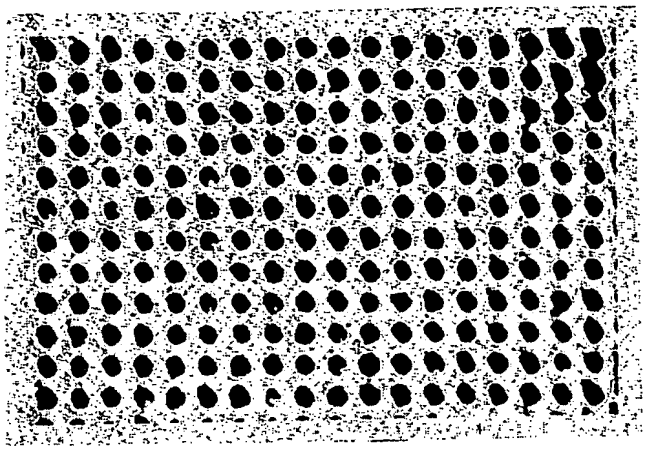


FIG. 3

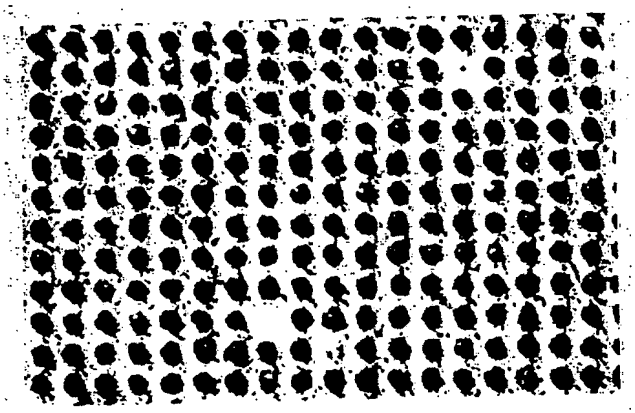
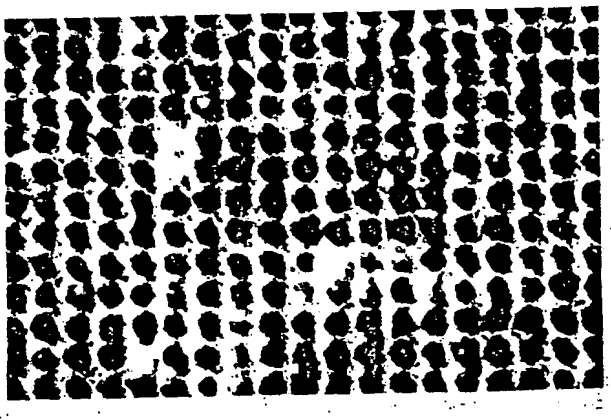


FIG. 4



SPECIFICATION

Method of producing medium-grade coated paper for rotogravure printing

The present invention relates to a method of producing medium-grade coated paper for rotogravure printing, the base paper of which contains high yield pulps, and to a method of rotogravure printing using such paper.

Recently, the importance of coated paper for printing as a medium for publication, advertisement, publicity, and the like, has been reappreciated. Particularly, the demand for medium-grade coated paper (corresponding to grades Nos. 3, 4 and 5 coated papers as set out at page 74 of "Pulp and Paper", May 1977) has been rapidly increasing because of the need for reducing the weight and cost of paper. In general, medium-grade coated paper is widely used in the field of light weight paper of weight 45 to 80 g/m^2 as compared with high-grade coated paper the base paper of which does not contain any high yield pulps (corresponding to grades Nos. 1 and 2 coated papers as set out in the above literature reference). In order, therefore, to compensate for the reduction of opacity resulting from the decrease in paper weight and to reduce the cost of paper, the base paper of medium-grade coated paper contains as 5 to 100% by weight of its pulp composition, high yield pulps of the following kinds: mechanical pulps (hereinafter referred to as "MP"), such as stone-ground pulp (hereinafter referred to as "SGP"), pressure stone-ground pulp (also hereinafter referred to as "SGP"), refiner-ground pulp (hereinafter referred to as RGP"), or thermo-mechanical pulp (hereinafter referred to as "TMP"; chemi-mechanical pulps (hereinafter referred to as "CMP"), such as chemi-thermo-mechanical pulp (hereinafter referred to as "CTMP") or chemi-ground pulps (hereinafter referred to as "CGP"); and semi-chemical pulp (hereinafter referred to as "SCP").

In many cases, medium-grade coated paper is to be subjected in use to rotogravure printing or web offset printing, both being high-speed printing processes. In rotogravure printing, unlike other printing processes, such as offset printing and letter press printing, the omission of gravure dots and defective reproduction thereof are liable to be seen because rotogravure printing is a unique printing process of transferring printing ink from an intaglio or a cell on a metal roll directly to paper. These are thus serious disadvantages exerting a bad influence upon the printing.

The omission of gravure dots, or speckle, can be seen on both high-grade and medium-grade coated papers. It is particularly liable to occur on medium-grade coated paper, because the high yield pulps contained in the base paper thereof contain more shives and bundles than do chemical pulps, even single fiber pieces of such pulps being rigid owing to the large amount of lignin contained therein, and a sufficient smoothness is not obtained even under pressed conditions with a super-calender finish for gravure printing. Remedies hitherto proposed include methods for removing shives and bundles from the high yield pulps, methods of decreasing long fiber fractions, improvements in gravure ink and improvements in gravure plate making, but none of them have been very successful.

The cause of defective reproduction of gravure dots is as follows. In rotogravure printing, much ink diluted with organic solvent is transferred from an intaglio or a cell to a coated paper surface and therefore the ink spreads on the coated paper surface at the time of transfer. The defective reproduction of gravure dots results in a defective reproduction of the original on the printed matter. As it is attributable to the basic process of rotogravure printing, no decisive remedies for it have as yet been obtained. The present applicants have made a study, not only of the base paper, but also of coating compositions, in order to find a way to decrease missing gravure dots and to improve the reproduction of gravure dots on medium-grade coated paper for rotogravure printing. As a result, the applicants have successfully obtained medium-grade coated paper, on which the number of missing gravure dots is decreased and the reproduction of gravure dots is improved, using a base paper containing high yield pulps having a particular fiber length distribution and a coating composition containing certain natural ground calcium carbonates in a specific proportion and a synthetic resin emulsion as a main adhesive.

It is thus an object of the present invention to provide a method of producing medium-grade coated paper for use in rotogravure printing, on which paper the omission of gravure dots is decreased and the reproduction of gravure dots is improved.

According to one aspect of the invention, there is provided a method of producing medium-grade coated paper for rotogravure printing, which comprises applying a coating composition to either surface or both surfaces of a base paper containing 10 to 100% by weight of one or more high yield pulps and optionally, 0 to 90% of one or more chemical pulps, the total proportion of said high yield pulp or pulps retained as a 12-mesh fiber fraction, a 24-mesh fiber fraction and a 42-mesh fiber fraction in screening thereof performed in accordance with the "Method of Screening Test of Paper Pulp" set forth in JIS (Japanese Industrial Standard) P8207, being below 30% by weight;

Said coating composition containing natural ground calcium carbonate having a specific surface area in the range of 1.5 to 5 m^2/g in an amount given by the following conditions:-

(i) when the specific surface area of the natural ground calcium carbonate is in the range of 1.5 to 2.5 m^2/g, the natural ground calcium carbonate is present in an amount in the range of 5 to (95S - 137.5)% by weight of the total pigments present (where "S" is the specific surface area in m^2/g of the natural ground calcium carbonate); and

(ii) when the specific surface area of the natural ground calcium carbonate is in the range of 2.5 to 5 m^2/g,

the natural ground calcium carbonate is present in an amount of in the range of 5 to 100% by weight of the total pigments present; and said coating composition containing as a main adhesive either at least one alkali-sensitive synthetic resin emulsion, or a mixture of at least one viscosity-increasing agent with at least one non-alkali-sensitive synethetic resin emulsion.

For the sake of brevity the total proportion of the high yield pulp or pulps retained as a 12-mesh fiber fraction, 24-mesh fiber fraction and 42-mesh fiber fraction is hereafter referred to as "42-mesh on fiber fraction content".)

According to a further aspect of the invention, there is provided a method of rotogravure printing using a medium-grade coated paper produced by such a method.

The invention will now be further described making reference to the drawings, in which:-

Figure 1 is a graph showing the relationship between the proportion by weight of natural ground calcium carbonate contained as a pigment in coating compositions according to the pesent invention with reference to the total pigment content, and the specific surface area of the natural ground calcium carbonate used;

Figure 2 is a photograph, magnified 40 times, of a gravure-printed surface of coated paper prepared as described in Inventive Example 2 below; and

Figures 3 and *4* are photographs, magnified 40 times, of gravure-printed surfaces of coated papers prepared as described in Comparative Examples 1 and 5 below, respectively.

The high yield pulps used in the present invention are conventional high yield pulps such as MP (SGP, RGP, TMP or the like), CMP (CTMP, CGP or the like) or SCP, and consist of unbleached high yield pulps, and/or or semibleached high yield pulps and/or bleached high yield pulps such as are widely used in newsprint paper, paper board, medium-grade paper, medium-grade coated paper, groundwood paper, and the like.

In the present invention only high yield pulps are used which, irrespective of their type, are below 30%, or preferably below 20%, or more preferably below 10% in 42 mesh on fiber fraction content.

The expression "42-mesh on fiber fraction content" of high yield pulp as used herein, means the total proportion of the high yield pulp retained as a 12-mesh fiber fraction, 24-mesh fiber fraction, and 42-mesh fiber fraction in screening of high yield pulp performed in accordance with the "Method of Screening Test of Paper Pulp" as set forth in JIS (Japanese Industrial Standard) P 8207. When a mixture of more than one kind of high yield pulp is used, the 42-mesh on fiber fraction content is determined by screening the mixture of the high yield pulps.

Of all high yield pulps usable in the present invention, high yield pulps with a 42-mesh on fiber fraction content of below 5% are the most preferred because they combine with the particular coating composition used in the present invention to decrease the omission of gravure dots to a very remarkable extent. However, it is undesirable to make the 42-mesh on fiber fraction content too low, because the yield of pulp and machining speed are reduced, and additional power is required for refining, post refining, and so on. The 42 mesh on fiber fraction content is therefore adjusted according to the content of the coating composition, and other factors present. Conventional high yield pulps most generally used in paper making have 42-mesh on fiber fraction contents as follows: 25 to 40% for SGP, 30 to 60% for RGP, and 35 to 75% for TMP. High yield pulps used in the present invention can be arranged to have a 42-mesh on fiber fraction content of below 30% by properly adjusting the manufacturing conditions, the refining conditions, the screening conditions, the post-refining conditions, and so on, of the high yield pulps. Part of lignin is sometimes removed from high yield pulps by oxidation or deoxidization. Because in this case the high yield pulps become like chemical pulps, the omission of gravure dots is decreased, but the original objects of using the high yield pulp to improve opacity and reduce paper cost cannot be attained. Such treatment is therefore preferably limited to an extent that the high yield pulps show brightness of below 80% when determined by means of a Hunter multipurpose reflectometer, and this applies also to the case of bleached waste paper.

The base paper used for the medium-grade coated paper at the present invention contains such high yield pulps in an amount of 10 to 100% by weight, and can be produced as follows: the high yield pulps are mixed with chemical pulp, waste paper pulp, broke pulp, and the like, and, according to need, with auxiliary agents such as fillers, sizes, retention aids, paper strengthening agents, dyestuffs, alum, pitch control agents, and anti-foaming agents. The pulp composition thus prepared is then made into paper under acid or alkaline conditions by means of a conventional single-wire or double-wire paper machine. Because a coating composition contaning natural ground clacium carbonate is applied in the coating process, alkaline paper making is preferable from a point of view of reutilizing brokes. If necessary, it is possible to apply starch, polyvinyl alcohol, polyacrylamide, or the like, as a surface size by means of a size press, gate roll coater or similar device during the paper making process.

The coating composition used for the present invention is applied to the base paper thus obtained and contains pigments and adhesives as its chief ingredients. The coating composition contains, as a pigment, natural ground calcium carbonate, having a specific surface area of 1.5m^2/g to 5m^2/g, in a proportion of above 5% by weight, preferably above 10% by weight, of the total pigment content.

This feature will now be discussed in more detail with reference to Figure 1 of the drawings, which is a graph showing the relationship of the proportion by weight of proportion of the total pigment content, consisting of natural ground calcium carbonate in the coating compositions used in the present invention, and the specific surface area of the calcium carbonate used. The proportion, by weight of natural ground

calcium carbonate contained as a pigment in a coating composition used in the present invention, of the total pigment content, is specified as follows according to the specific surface area of the natural ground calcium carbonate used, and is indicated by the shaded portion of the graph of Figure 1:-

(i) when the specific surface area is in the range of 1.5 to 2.5m^2/g; the proportion used is 5 to (95S-137.5)% by weight, of the total pigments ("S" representing the specific surface area m^2/g); and

(ii) when the specific surface area is in the range of 2.5 to 5 m^2/g; the proportion used is 5 to 100% by weight, of the total pigments.

If natural ground calcium carbonate having a specific surface area of below 1.5m^2/g is used, or if natural ground calcium carbonate having a specific surface area in the range of 1.5 m^2/g is used in an amount in excess of the specified range, the microscopic smoothness of the coated surfaces is affected and the number of missing gravure dots rather increases. Consequently, in the present invention, natural ground calcium carbonate having a specific surface area of at least 1.5 m'g is used within the aforesaid proportion range. In the case of natural ground calcium carbonate having a specific surface area of above 5 m^2/g, ink gloss and printed surface strength are reduced, and therefore it is necessary to increase the amount of adhesives in the coating composition. Consequently, in the present invention, natural ground calcium carbonate having a specific surface area of not more than 5 m^2/g is used.

Natural ground calcium carbonate can be prepared as follows: limestone, sparite, micrite, marble, calcite, natural chalk, or like material, is ground into fine particles one or more times by a dry or wet process using mechanical means, such as a crusher, pebble mill, hammer mill, micron mill, ball mill, jet mill, attritor, sand mill, attrition mill, or like device, and is as necessary, classified by air elutriation, or hydraulic elutriation, for example, and is further condensed and dried. Natural ground calcium carbonate for paper coating thus obtained in the form of slurry or a dry powder, is used in the present invention.

Particularly, it is preferred to use natural ground calcium carbonate processed to satisfy formula (I) below, and more preferably formula (2) below, as is disclosed in Japanese Patent Specifications Nos. Sho 53-81709, and Sho 53-40462, by being mechanically ground by a wet process, either continuously or batchwise, by means of a sand mill, attrition mill, attritor, agitation mill, or the like, with natural or synthetic particles not exceeding about 5 mm in diameter, such as Ottawa sand, glass beads, ceramic beads, silicate beads, zirconium beads, as the grinding medium (hereinafter referred to as "sand mill treatment").

$$p \geq \frac{0.5}{N} + N \text{---------(1)}$$

$$p \geq \frac{0.8}{N} + N \text{---------(2)}$$

(where "N" represents the specific surface area in m^2/g of the calcium carbonate before sand mill treatment, and "P" represents the specific surface area in m^2/g after the sand mill treatment).

A coating composition containing such natural ground calcium carbonate processed by such sand mill treatment to have a specific surface area of 2m^2/g is excellent as regards fluidity and water retention, and is free from streaks, and even if such natural ground calcium carbonate is used in a high proportion of above 20% by weight of the total pigments, the advantages of decreasing the number of missing gravure dots and improving the reproduction of the gravure dots are maintained.

Pigments which may be present, along with the natural ground calcium carbonate, in the coating compositions used in the present invention may be such conventional pigments for paper coating as Kaolin, clay, barium sulfate, precipitated calcium carbonate, aluminium hydroxide, satin white, titanium dioxide, calcium sulfite, zinc sulfate, and plastic pigment, mixed according to their respective properties. It is to be understood that these are merely examples and that the pigments which may be used in the present invention are not limited thereto.

The coating compositions used in the present invention contain either alkali-sensitive synthetic resin emulsions, or non-alkali-sensitive synthetic resin emulsions, mixed with one or more viscosity increasing agents, as a main adhesive for fixing the pigments to the base paper. Some examples of suitable alkali-sensitive resin emulsion include aqueous dispersions of copolymers consisting of styrene, butadiene or an ethylenically-unsaturated monocarboxylic acid ester, and an ethylenically-unsaturated carboxylic acid (see German Patent Specification No. 1919379); aqueous dispersions of copolymers consisting of styrene, butadiene or acrylonitrile, and an ethylenically-unsaturated carboxylic acid (see US Patent Specification No. 3409569); aqueous dispersions of copolymers consisting of a conjugated diolefin unsaturated compound in an amount of 5 to 30% by weight, an ethylenically unsaturated carboxylic acid, an ethylenically unsaturated dicarboxylic acid monoester, or other copolymerizable monoolefin unsaturated compound (see Japanese Patent Specification No. Sho 49-44948); aqueous dispersions of an alkali-soluble copolymer latex obtained by copolymerizing acrylic acid or methacrylic acid and their low-grade esters, the copolymer latex being blended with a styrene-butadiene copolymer latex (see Japanese Patent Specification No. Sho 38-10357); aqueous dispersions of an alkali-soluble copolymer latex obtained by copolymerizing acrylic acid or methacrylic acid, their low-grade esters, acrylamide, or methacrylamide, with styrene or vinyl acetate, the copolymer latex being blended with a latex obtained by copolymerizing an acrylic ester or methacrylic ester with a vinyl ester of a monocarboxylic acid (see US patent Specification No. 3365410); aqueous dispersions of an alkali-soluble, styrene-butadiene-ethylenically-unsaturated carboxylic acid copolymer latex, or a vinyl

acetate-ethylenically-unsaturated carboxylic acid copolymer latex, in each case copolymerized with above 30% of an ethylenically-unsaturated carboxylic acid, the copolymer latex being blended with a styrene-butadiene copolymer latex; and various other alkali-sensitive synthetic resin emulsions which are already known as single-binder adhesives, as well as aqueous emulsions comprising alkali-sensitive or alkali-soluble synthetic resin emulsions and non-alkali-sensitive synthetic resin emulsions. Among such alkali-sensitive synthetic resin emulsions, there may particularly be mentioned that the alkali-sensitive synthetic resin emulsion containing styrene, butadiene, or an ethylenically-unsaturated carboxylic acid as their chief ingredient, and aqueous emulsions of an alkali -soluble copolymer latex blended with a non-alkali sensitive styrene-butadiene copolymer latex are preferably used because they help to improve the reproduction of gravure dots and to facilitate the super-calender finishing of coated paper.

The non-alkali-sensitive synthetic resin emulsions used in the present invention are not carboxylated at all or are carboxylated to only a low degree, and may be any of various synthetic resin emulsions usually used as adhesives in coating compositions. Some examples of such emulsions include conjugated diene copolymer latexes, such as styrene-butadiene copolymer and methyl methacrylate-butadiene copolymer latexes; acrylic polymer latexes such as polymers or copolymers of acrylic and/or methacrylic esters; and polyvinyl acetate latexes, such as ethylene-vinyl acetate copolymer latexes. The viscosity-increasing agent or agents used, together with such non-alkali-sensitive synthetic resin emulsion, in the present invention may be one or more types of natural or synthetic water-soluble high-molecular weight compounds such as are generally used as viscosity-increasing agents, water-retention agents, flow modifiers or adhesives in coating compositions. Examples of such materials include sodium alginate, guar gum, cellulose derivatives, such as carboxymethyl cellulose, hydroxyethyl cellulose, hydroxymethyl cellulose and methyl cellulose; water-soluble synthetic resins such as polyacrylates, salts of styrene-maleic acid copolymers, polyvinyl alcohol and salts of isobutene-maleic acid copolymers; starches, such as oxidized starch, esterified starch, cationic starch and enzyme-modified starch; and proteins, such as casein, soyabean protein and petroleum protein.

The coating compositions used in the present invention contain as their main adhesives, such alkali-sensitive emulsions, or non-alkali-nonsensitive synthetic resin emulsion and viscosity-increasing agents(s), as mentioned above. If the proportion of the synthetic resin emulsion to 100 parts by weight of pigments is below 3 parts by weight, the adhesive strength is reduced and water-soluble high molecular adhesives, such as starches and proteins have to be used in quantity. As a result, the number of missing gravure dots is not satisfactorily decreased. If the proportion of the synthetic resin emulsion to 100 parts by weight of pigments is above 25 parts by weight, the advantages of decreasing the number of missing gravure dots and improving the reproduction of gravure dots are affected, and the coated paper is liable to stick to rollers at the time of super-calender finishing. Consequently, the proportion of the synthetic resin emulsion used per 100 parts by weight of pigments is preferably in the range of 3 to 25 parts by weight, more preferably 5 to 15 parts by weight.

The viscosity-increasing agent or agents used together with the non-alkali sensitive synthetic resin emulsion should not exceed the emulsion in amount by weight. The use of such agents in a larger proportion does not help to obtain the desired effects of the invention. The proportion of the viscosity-increasing agent or agents to 100 parts by weight pigments is preferably 0.01 to 4 parts by weight, more preferably 0.1 to 2 parts by weight.

The coating compositions used in the present invention which contain alkali-sensitive synthetic resin emulsions as their main adhesive may be made more viscous generally by bringing their pH to 7.5 to 13.0 by the addition of suitable alkaline material, but it is also possible to use one or more of said viscosity-increasing agents, as required, under the same conditions as in the case of non-alkali-sensitive synthetic resin emulsions for this purpose.

It is possible to mix the coating compositions used in the present invention, as required, with auxiliary agents such as dispersants, flow modifiers, anti-foaming agents, dyestuffs, lubricants, insolubilizers and water-retention agents to an extent such that they do not adversely affect the advantages of the invention.

In the present invention, the base paper may be single-coated or multiple-coated on either surface, or on both surfaces thereof, with the coating composition by means of an on-machine or off-machine coated so that a coating weight on one surface of above 2 g/m^2, preferably above 5 g/m^2 (in terms terms of solid matter) is obtained. The make up of the coating composition on each surface and that of the coating composition forming each layer in multiple coatings may be varied suitably if required. Coating may be effected by any known process and by means of any conventional coating machine, for instance, an air knife coater, roll coater, puddle-type or inverted blade coater with bevel or bent blade, Bill blade coater, twin blade coater, or Champflex coater. Amongst these coating machines, the blade coaters are preferably used because they give smoother coated surfaces.

On the medium-grade coated paper for rotogravure printing of the present invention, the number of missing gravure dots are decreased to a remarkable extent, the reproduction of gravure dots is remarkably improved, and an excellent paper gloss is obtained. It is not clear why such advantages are obtained, but it seems that the particular base paper used combines with the particular coating composition used to multiply the advantages. The use of a composition with a single binder in a coating composition for rotogravure printing paper is described in Tappi Vol. 51 No. 2 p. 86A to 91A, and Tappi Vol. 50 No. 12 p. 622 to 629, API June 1975 p.24 to 25. When such a coating composition is used, the number of missing gravure dots is

decreased to some extent, but the reproduction of gravure dots is not improved so much as with the paper of the present invention. It is surmised that the presence of fine natural ground calcium carbonate in a specific proportion in the coating composition used in the present invention helps the absorption of the gravure ink solvent in connection, for instance, with the porosity of coats, and contributes to improving the reduction of gravure dots. In any case, by means of the present invention, it is possible to obtain medium-grade coated paper for rotogravure printing, on which paper the number of missing gravure dots is remarkably decreased and the reproduction of gravure dots is remarkably improved. Particularly when the proportion of natural ground calcium carbonate with reference to the total pigments is above 20% by weight, the coating composition has much increased fluidity and water retention, and it is possible to obtain, with a very high efficiency using a blade coater, coated paper which has a high efficiency using a blade coater, coated paper which has a high degree of whiteness and is free from troubles such as streaks, scratches and stalactites.

The present invention will now be further described with reference to a number of examples, and to Figures 2 to 4, which are enlarged photographs of gravure-printed papers, both according to the invention (Figure 2) and not according to the invention (Figures 3 and 4). It will however, be understood that the present invention is not limited to the examples. In the examples, parts or percentages are by weight, unless otherwise stated.

Inventive Example 1

Base paper of 40 g/,^{2} for medium-grade coated paper was obtained from paper stuff comprising 1 part rosin size, 3 parts alum and 5 parts talc filler respectively added to a pulp composition consisting of 15 parts SGP, treated by post refining, to have a 42-mesh on fiber fraction content of 4%, 65 parts needle-leaved bleached kraft pulp (hereinafter referred to as "NBKP") having a Canadian Standard Freeness (hereinafter referred to as "CSF") of 550 cc and 20 parts broad-leaved bleached kraft pulp (hereinafter referred to as "LBKP") having a CSF of 450 cc. (The last three "parts" mean parts by weight of bone dry pulp). A coating composition with a concentration of 60% was obtained by dispersing 15 parts natural ground calcium carbonate having a specific surface area of 1.6 m^2/g ("Super 1700" made by Maruo Calcium Co., Japan) and 85 parts kaolin ("UW-90" made by Engelhard Minerals & Chemicals Corporation, USA) in water with 0.2 part sodium polyacrylate as dispersant, so as to give a solids content of 65%, adding thereto as adhesives 0.4 part (solid matter) of alkali-soluble acrylic emulsion ("Sterocoll ST" made by Badische Anilin-& Soda Fabrik AG, West Germany) and 7 parts (solid matter) of non-alkali-sensitive acrylic emulsion ("Acronal 500D" made by BASF, West Germany) and raising the pH of the dispersion to 9.5 by addition of caustic soda. The coating composition was applied to the said base paper by means of a blade coater so as to give a dry coating weight on both surfaces of 24 g/m^2. Then, the paper was dried, and treated by means of a super-calender. Medium-grade coated paper of 64 g/m^2 was thus obtained. The medium-grade coated paper was subjected to paper quality tests, the results of which are shown in Table 1 below.

The specific surface area of the natural ground calcium carbonate was measured as follows by means of a powder surface area determinator (made by Shimadzu-Corp. Japan). A 3 g sample was placed in a sample tube 2 cm^2 x 1 cm in size, and the specific surface area was calculated from the time required for 20 cc of air to pass through it at a 600 mm water column pressure. (In all of the following examples, the specific surface area of the natural ground calcium carbonate was measured in this way.)

In *Comparative Example 1,* medium-grade coated paper was obtained in the same way as in Inventive Example 1, except that the proportions of natural ground calcium carbonate and kaolin in the coating composition were changed to 30 parts and 70 parts respectively; 2.5 parts (solid matter) of an alkali-sensitive emulsion ("Acronal ST425D" made by BASF, West Germany) was used as adhesive; and 3 parts of carboxymethyl cellulose was used as a viscosity-increasing agent. The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are also shown in Table 1. In Comparative Example 1, the adhesive strength of the coatings was too weak, and the rolls of the super-calender and winder were soiled. It was therefore impossible to operate continuously.

Inventive Example 2

Base paper for medium-grade coated paper was obtained in the same way as in Inventive Example 1, except that the pulp composition consisted of 35 parts RGP treated to have a 42-mesh on fiber fraction content of 9%, 40 parts NBKP having a CSF of 550 cc and 25 parts LBKP having a CSF of 450 cc.

A coating composition was obtained in the same way as in Inventive Example 1, except that the pigments consisted of 40 parts natural ground calcium carbonate with a specific surface area of 1.9 m^2/g ("Escalon 2000" made by Sankyo Seihun KK, Japan) and 60 parts kaolin ("HT Clay" made by EMC, USA); and the adhesive was 5 parts (solid matter) of an alkali-sensitive emulsion obtained by blending an alkali-soluble copolymer emulsion, consisting of 3 parts methacrylic acid, 5 parts vinyl acetate and 10 parts acrylic acid, with a non-alkali-sensitive copolymer emulsion, consisting of 25 parts styrene, 40 parts butadiene, 15 parts methyl methacrylate and 2 parts acrylic acid, in a proportion of 18 to 82 (solid matter). The coating composition was applied to the base paper and dried in the same way as in Inventive Example 1. The coated paper was treated by means of a super-calender to obtain medium-grade coated paper. The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1.

In *Comparative Example 2,* medium-grade coated paper was obtained in the same way as in Inventive Example 2, except that the 42-mesh on fiber fraction content of RGP was 35%. The medium-grade coated

paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1.

Inventive Example 3

Base paper for medium-grade coated paper was obtained in the same way as in Inventive Example 1, except that the pulp composition consisted of 35 parts TMP treated to have a 42-mesh on fiber fraction content of 9%, 32.5 parts NBKP having a CSF of 550 cc and 32.5 parts LBKP hving a CSF of 450 cc. Natural ground calcium carbonate with a specific surface area of 1.5 m^2/g ("Softon 1500" made by Bihoku Funka Co., Japan) was processed to have a specific surface area of 2.1 m^2/g by dispersing it in water by means of a turbine type agitator and with 0.2% sodium polyacrylate as dispersant, so as to give a solids content of 70%, and by grinding the slurry thus obtained by means of a sand grinder (model "32G" made by Igarashi Kikai Seizo Co., Ltd. Japan) at a speed of 1,000 rpm and a flow of 400 liters per hour, using glass beads of about 2.5 mm average diameter as a grinding medium. A coating composition was prepared in the same way as in Inventive Example 1, except that 50 parts natural ground calcium carbonate thus obtained and 50 parts kaolin ("Hydrasheen 90" made by Huber Corporation, USA) were used as pigments; 10 parts (solid matter) of an alkali-sensitive copolymer emulsion consisting of 25 parts methyl methacrylate, 20 parts styrene, 10 parts acrylic acid and 45 parts butadiene was used as adhesive; and 1 part oxidized starch ("MS3800" made by Nippon Shokuhin-Kako KK, Japan) was used as a viscosity-increasing agent. The coating composition was applied to the base paper and dried in the same way as in Inventive Example 1.

The coated paper was treated by means of a super-calender to obtain medium-grade coated paper. The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1.

In *Comparative Example 3,* medium-grade coated paper was obtained in the same way as in Inventive Example 3, except that the pigments in the coating composition consisted of 75 parts natural ground calcium carbonate and 25 parts kaolin; the adhesive was 5 parts (solid matter) of an alkali-sensitive emulsion obtained by blending an alkali-soluble copolymer emulsion consisting of 25 parts methacrylic acid and 8 parts acrylic acid, with a non-alkali-nonsensitive copolymer emulsion, consisting of 35 parts styrene, 30 parts butadiene and 2 parts acrylic acid, in a proportion of 33 to 67 (solid matter); and the viscosity-increasing agent was 5 parts (solid matter) oxidized starch ("MS3800" made by Nippon Shokuhin Kako KK, Japan). The medium-grade coated paper thus obtained was subjected to paper quality test, the results of which are shown in Table 1.

Inventive Example 4

Base paper of 35 g/m^2 for medium-grade coated paper was obtained from paper stuff comprising 0.5 part rosin size, 3 parts alum, 3 parts kaolin filler and 0.3 part of polyacrylamide resin as a paper-strengthening agent, respectively added to a pulp composition consisting of 30 parts TMP adapted to have a 42-mesh on fiber fraction content of 25%, 20 parts SGP which was the same as that used in Inventive Example 1, and 50 parts NBKP which was also the same as that used in Inventive Example 1.

Natural ground calcium carbonate with a specific surface area of 1.5 m^2/g ("Softon 1500" made by Bihoku Co., Japan) was treated to have a specific surface area of 2.3 m^2/g by dispersing it in water with a dispersant so as to give a solids content of 60%, and by treating the slurry thus obtained by means of an attrition mill having silicate beads of about 1 mm average diameter. A coating composition was obtained in the same way as in Inventive Example 1, except that 75 parts of natural ground calcium carbonate so obtained and 25 parts kaolin ("UW-90" made by EMC, USA) were used as pigments; 4 parts (solid matter) of an alkali-sensitive synthetic resin emulsion, consisting of 31 parts styrene, 31 parts butadiene, 10 parts methyl methacrylate, 15 parts acrylic acid and 13 parts methacrylic acid, and 8 parts (solid matter) of a styrene-butadiene copolymer emulsion ("JSR 06 96" made by Japan Synthetic Rubber Co., Ltd., Japan) were used as adhesives; and 0.05 part (solid matter) carboxymethyl cellulose ("AG Gum" made by Daiichi Kogyo Seiyaku KK, Japan) was used as a viscosity-increasing agent. The coating composition was applied to the base paper and dried in the same way as in Inventive Example 1. The coated paper was treated by means of a super-calender to obtain medium-grade coated paper. The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1.

In *Comparative Example 4,* medium-grade coated paper was obtained in the same way as in Inventive Example 4, except that the pigment in the coating composition consisted of 100 parts natural ground calcium carbonate. The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1.

Inventive Example 5

Base paper for medium-grade coated paper was obtained in the same way as in Inventive Example 1, except that the pulp composition consisted of 20 parts RGP treated to have a 42-mesh on fiber fraction content of 25%, 20 parts NBKP having a CSF of 550 cc and 60 parts LBKP having a CSF of 450 cc. Natural ground calcium carbonate with a specific surface area of 0.1 m^2/g was treated to have a specific surface area of 3 m^2/g by dispersing it in water with 1.0% sodium polyacrylate as dispersant so as to give a solids content of 70%, and treating the slurry thus obtained by means of a sand mill. A coating composition was obtained in the same way as in Inventive Example 1, except that 100 parts natural ground calcium carbonate thus obtained was used as a pigment; and 2 parts (solid matter) of a copolymer emulsion, consisting of 20 parts

monoisobutylmalate, 30 parts styrene, 40 parts butadiene and 10 parts acrylic acid, and 10 parts (solid matter) of a copolymer emulsion, consisting of 58 parts styrene, 40 parts butadiene and 2 parts itaconic acid, were used as adhesives. The coating composition was applied to the base paper and dried in the same way as in Inventive Example 1. The coated paper was treated by means of a super-calender to obtain medium-grade coated paper. The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1.

Inventive Example 6

Base paper for medium-grade coated paper was obtained in the same way as in Inventive Example 1, except that the pulp composition consisted of 70 parts SGP adapted to have a 42-mesh on fiber fraction content of 5% and 30 parts NBKP having a CSF of 550 cc. Natural ground calcium carbonate with a specific surface area of 0.08 m^2/g was treated to have a specific surface area of 4.5 m^2/g by dispersing it in water with 0.6% sodium polyacrylate and 0.2% tetrasodium pyrophosphate as dispersants so as to give a solids content of 73%, and treating the slurry thus obtained by means of a horizontal sand mill ("Dynomill" made by Willy A. Bachofen AG, West Germany).

A coating composition with a solids content of 63%, comprising 100 parts natural ground calcium carbonate thus obtained, 5 parts (solid matter) of an adhesive consisting of an acrylic alkali-sensitive synthetic resin emulsion ("Acronal ST420D" made by BASF, West Germany), some dyestuff, some antifoaming agent, some insolublizer and some ammonia, was applied to the base paper by means of a blade coater so as to give a dry coating weight on both surfaces of 26 g/m^2. The paper was then dried, and treated by a super-calender to obtain medium-grade coated paper. The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1.

Inventive Example 7

Medium-grade coated paper was obtained in the same way as in inventive Example 1, except that the pulp composition consisted of 35 parts RGP treated to have a 42-mesh on fiber fraction content of 15% and 65 parts LBKP having a CSF of 500 cc; pigments in the coating composition consisted of 80 parts natural ground calcium carbonate treated to have a specific surface area of 2.5 m^2/g by means of an attritor and 20 parts kaolin ("HT Clay" made by EMC, USA): adhesives therein consisted of 20 parts (solid matter) of a methyl methacrylatebutadiene copolymer emulsion ("ML 717" made by Mitsui Toatsu Chemicals Inc., Japan) and 1 part (solid matter) of carboxymethyl cellulose; and no caustic soda was added. The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1.

Inventive Example 8

Base paper of 50 g/m^2 for medium-grade coated paper was obtained from paper stuff comprising 0.05 part of an alkylketene dimer size ("Hercon 40" made by Dic Hercules Co., Japan), 0.05 part of polyamide epichlorhydrin as a fixing agent, ("Kymene" made by Dic Hercules Co., Japan), 1.0 part of cationic starch as a paper strengthening agent and 3 parts of natural ground calcium carbonate as a filler, respectively added to a pulp composition consisting of 30 parts SGP treated to have a 42-mesh on fiber fraction content of 20%, 55 parts NBKP having a CSF of 550 cc and 15 parts LBKP having a CSF of 450 cc.

A coating composition was obtained in the same way as in Inventive Example 1, except that the pigments therein consisted of 60 parts natural ground calcium carbonate whose specific surface area was changed from 1 m^2/g to 4m^2/g by treatment at a concentration of 65% by means of an attrition mill, 20 parts kaolin ("HT Clay" made by EMC, USA) and 20 parts aluminium hydroxide ("Higilite H-42" made by Showa Denko KK, Japan); the adhesive therein was 4 parts (solid matter) of a styrene-butadiene copolymer emulsion ("JSR-0697" made by Japan Synthetic Rubber Co., Ltd., Japan); and the viscosity-increasing agent used therein was 3 parts (solid matter) of phosphatic ester starch ("Nylgum M-85" made by Avebe Corp., Holland). The coating composition thus obtained was applied to the base paper and dried in the same way as Inventive Example 1. The coated paper was treated by means of a super-calender to obtain medium-grade coated paper. The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1.

Comparative Example 5

Medium-grade coated paper was obtained in the same way as in Inventive Example 1 except that the pigment in the coating composition consisted of 100 parts kaolin; and the adhesives therein comprised 28 parts (solid matter) of a styrene-butadiene copolymer emulsion ("SN-304" made by Sumitomo Naugatuch Co., Ltd., Japan) blended with 0.4 part (solid matter) of an alkali-soluble acrylic emulsion ("Sterocoll ST" made by BASF, West Germany). The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1. When processed in a super-calender, the coated paper had a strong tendency to stick to super-rolls, and was inferior in workability.

Comparative Example 6

Medium-grade coated paper was obtained in the same way as in Inventive Example 2 except that the pigments in the coating composition consisted of 50 parts of precipitated calcium carbonate ("PZ" made by Shiraishi Kogyo KK, Japan) and 50 parts of kaolin ("HT Clay" made by EMC, USA). The medium-grade

coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1. In this case, rolls used in each process, including super-calender rolls, were soiled, and the workability of the coated paper was very bad.

Comparative Example 7

Medium-grade coated paper was obtained in the same way as in Inventive Example 1, except that adhesives in the coating composition consisted of 10 parts (solid matter) of a methyl methacrylate-butadiene copolymer emulsion (ML-717" made by Mitsui Toatsu Chemicals Inc., Japan) and 5.5 parts (solid matter) of oxidized starch; and no caustic soda was used. The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1.

Comparative Example 8

Medium-grade coated paper was obtained in the same way as in Inventive Example 1, except that the pigments in the coating composition consisted of 10 parts natural ground calcium carbonate with a specific surface area of 1.3 m^2/g and 90 parts of kaolin ("UW-90" made by EMC, USA). The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1.

Comparative Example 9

Medium-grade coated paper was obtained in the same way as in Inventive Example 1, except that the adhesives in the coating composition consisted of 4 parts (solid matter) of a styrene-butadiene copolymer emulsion ("JSR-0696" made by Japan Synthetic Rubber Co., Ltd., Japan), 0.3 part (solid matter) of carboxymethyl cellulose and 4 part (solid matter) of casein. The medium-grade coated paper thus obtained was subjected to paper quality tests, the results of which are shown in Table 1.

The results of the paper quality tests shown in Table 1 were obtained by visually evalutating medium-grade coated papers printed in accordance with No. 24 m "Method of Testing Gravure Printability of Paper (Method of the Printing Bureau)" in J. TAPPI "Method of Testing Paper Pulp". In Table 1, the results of the paper quality tests are represented by the following four relative grades:

◎ ---------- Very Good
○ ---------- Good
△ ---------- Bad
X ---------- Very Bad

Figures 2, 3 and 4 are enlarged photographs (magnified 40 times) of gravure-printed surfaces of medium-grade coated papers respectively obtained in Inventive Example 2, Comparative Example 1 and Comparative Example 5.

TABLE 1

Inventive Example	Missing Gravure Dots	Reproduction of Gravure Dots
1	◎	○
2	◎	◎
3	◎	◎
4	○	◎
5	○	◎
6	◎	◎
7	○	◎
8	○	○
Comparative Example		
1	X	○
2	X	◎
3	X	◎
4	X	◎
5	X	X
6	△	◎
7	X	X
8	X	△
9	X	X

As can be seen from Table 1 and Figures 2 to 4, paper obtained in each Inventive Example of the present invention reproduced gravure dots better and with fewer missing gravure dots than did medium-grade coated paper obtained in any Comparative Example, and had well-balanced high quality as a medium-grade coated paper for rotogravure printing.

Since many apparently widely different examples of the invention can be made without departing from the scope thereof, it is to be understood that the invention is not limited to the specific examples thereof given above but is defined in the appended Claims.

CLAIMS

1. A method of producing medium-grade coated paper for rotogravure printing, which comprises applying a coating composition to either surface or both surfaces of a base paper containing 10 to 100% by weight of one of more high yield pulps and optionally, 0 to 90% of one or more chemical pulps, the total proportion of said high yield pulp of pulps retained as a 12-mesh fiber fraction, a 24-mesh fiber fraction and a 42-mesh fiber fraction in screening thereof performed in accordance with the "Method of Screening Test of Paper Pulp" set forth in JIS (Japanese Industrial Standard) P 8207, being below 30% by weight;

said coating composition containing natural ground calcium carbonate having a specific surface area in the range of 1.5 to 5 m^2/g in an amount given by the following conditions:-

(i) when the specific surface area of the natural ground calcium carbonate is in the range of 1.5 to 2.5 m^2/g, the natural ground calcium carbonate is present in an amount in the range of 5 to (95S-137.5)% by weight of the total pigments present (where "S" is the specific surface area in m^2/g of the natural ground calcium carbonate); and

(ii) when the specific surface area of the natural ground calcium carbonate is in the range of 2.5 to 5 m^2/g, the natural ground calcium carbonate is present in an amount of in the range of 5 to 100% by weight of the total pigments present;

and said coating composition containing as a main adhesive either at least one alkali-sensitive synthetic resin emulsion or a mixture of at least one viscosity-increasing agent with at least one non-alkali-sensitive synthetic resin emulsion.

2. A method as claimed in Claim 1, wherein the total proportion of said high yield pulp or pulps retained as said 12-mesh, 24-mesh and 42-mesh fiber fractions is below 20% by weight.

3. A method as claimed in Claim 2, wherein said total proportion of said high yield pulp or pulps is below 10% by weight.

4. A method as claimed in Claim 3, wherein said total proportion of said high yield pulp or pulps is below 5% by weight.

5. A method as claimed in any one of the preceding Claims, wherein said natural ground calcium carbonate in said coating composition is above 10% by weight of the total pigments present.

6. A method as claimed in any one of the preceding Claims, wherein said natural ground calcium carbonate contained as a pigment in said coating composition is given a specific surface area of 2 to 5 m^2/g by sand mill treatment.

7. A method as claimed in any one of the preceding Claims, wherein said main adhesive in said coating composition is an alkali-sensitive synthetic resin emulsion.

8. A method as claimed in Claim 7, wherein said alkali-sensitive synthetic resin emulsion contains styrene, butadiene or an ethylenically-unsaturated carboxylic acid as its chief ingredient.

9. A method as claimed in any one of the preceding Claims wherein said coating composition is applied to either surface or to both surfaces of said base paper so that its coating weight on the or each surface is above 2 g/m^2 (based on solid matter).

10. A method of producing medium-grade coated paper for rotogravure printing, substantially as hereinbefore described with reference to any one of Inventive Examples 1 to 8.

11. Medium-grade coated paper for rotogravure printing produced by a method as claimed in any one of Claims 1 to 10.

12. A method of rotogravure printing using medium-grade coated paper as claimed in Claim 11 as the printed medium.

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